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Koyama

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(54) **IMAGE FORMING APPARATUS WITH A HEAT-CONTROLLABLE FIXING UNIT AND COMPUTER READABLE MEDIUM FOR IMAGE FORMING APPARATUS**

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CPC ***G03G 15/2039*** (2013.01); ***G03G 15/2017*** (2013.01)

(58) **Field of Classification Search**
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USPC 399/69
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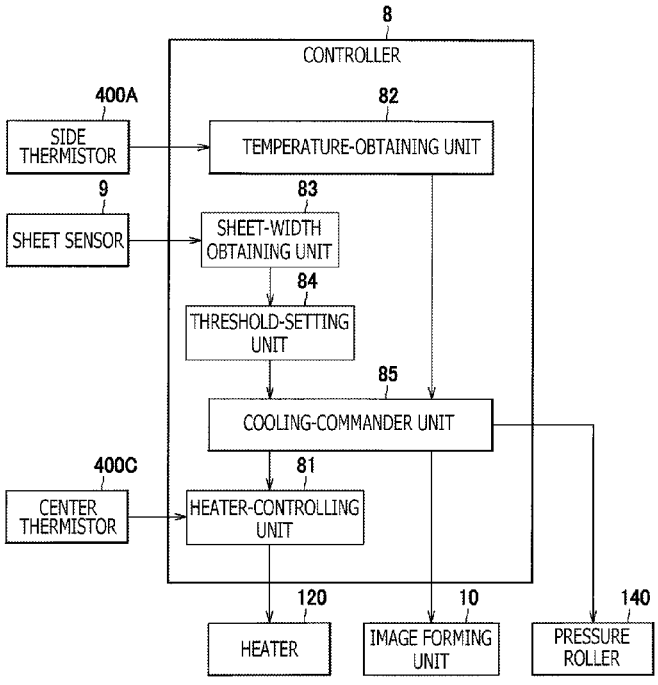
(57) **ABSTRACT**

An image forming apparatus, including an image forming unit, a fixing unit with a heater, an end temperature sensor to detect a temperature in an end area an end area of the fixing unit, and a controller, is provided. The controller is configured to perform a width obtaining step to obtain the width of the sheet, a temperature obtaining step to obtain the detected temperature of the fixing unit, a comparison step to compare the detected temperature with a threshold, a cooling step to let the end area of the fixing unit cool down when the detected temperature is one of higher and equal to the threshold, and a threshold-setting step to set one of a first value and a second value to be the threshold depending on the width of the sheet obtained in the width obtaining step.

17 Claims, 10 Drawing Sheets



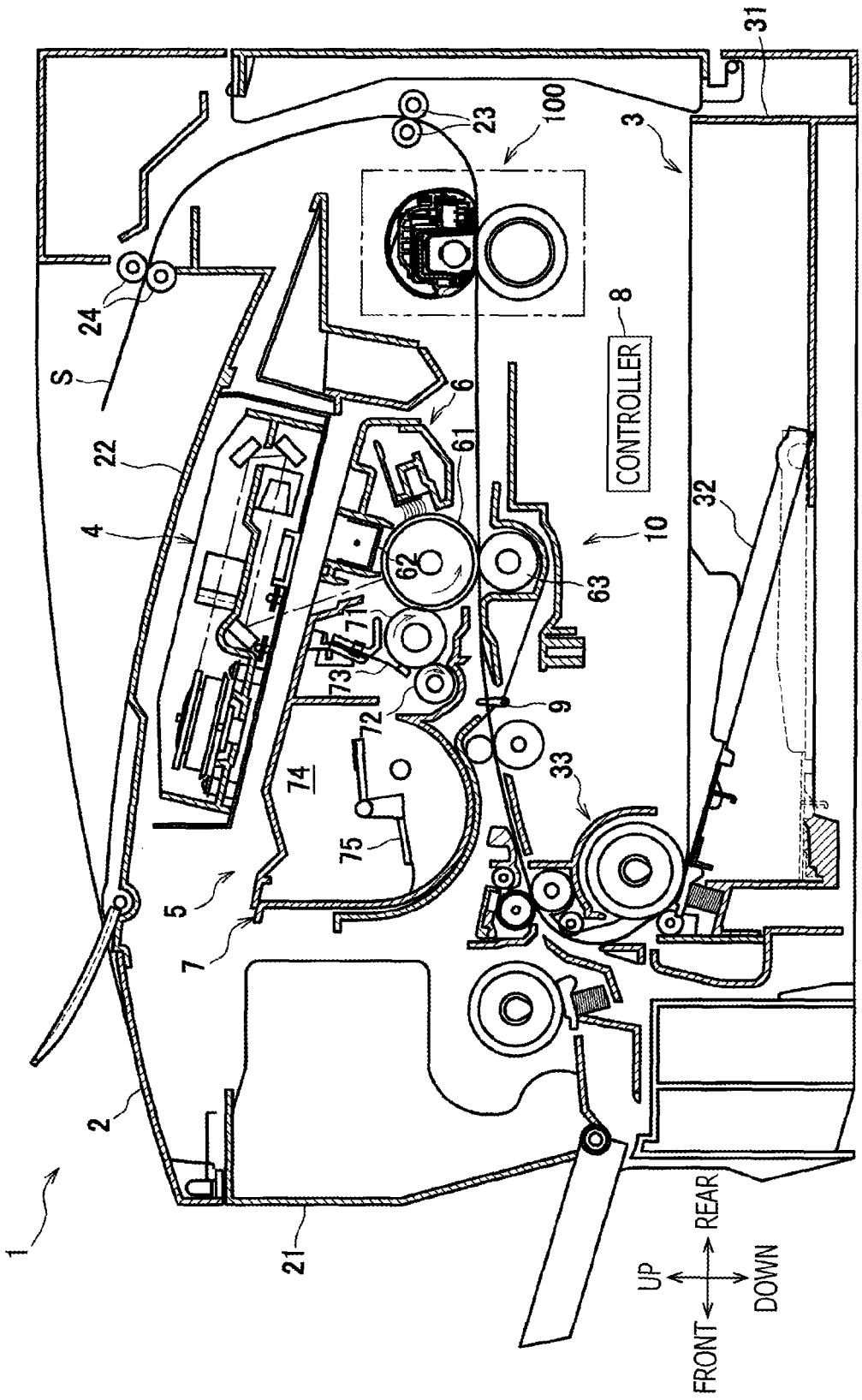

1
2
21
4
5
7
22
24
S
23
100
3
31
6
61
62
63
71
73
72
74
75
9
33
32
10
8
CONTROLLER
UP
DOWN
FRONT
REAR

FIG. 1

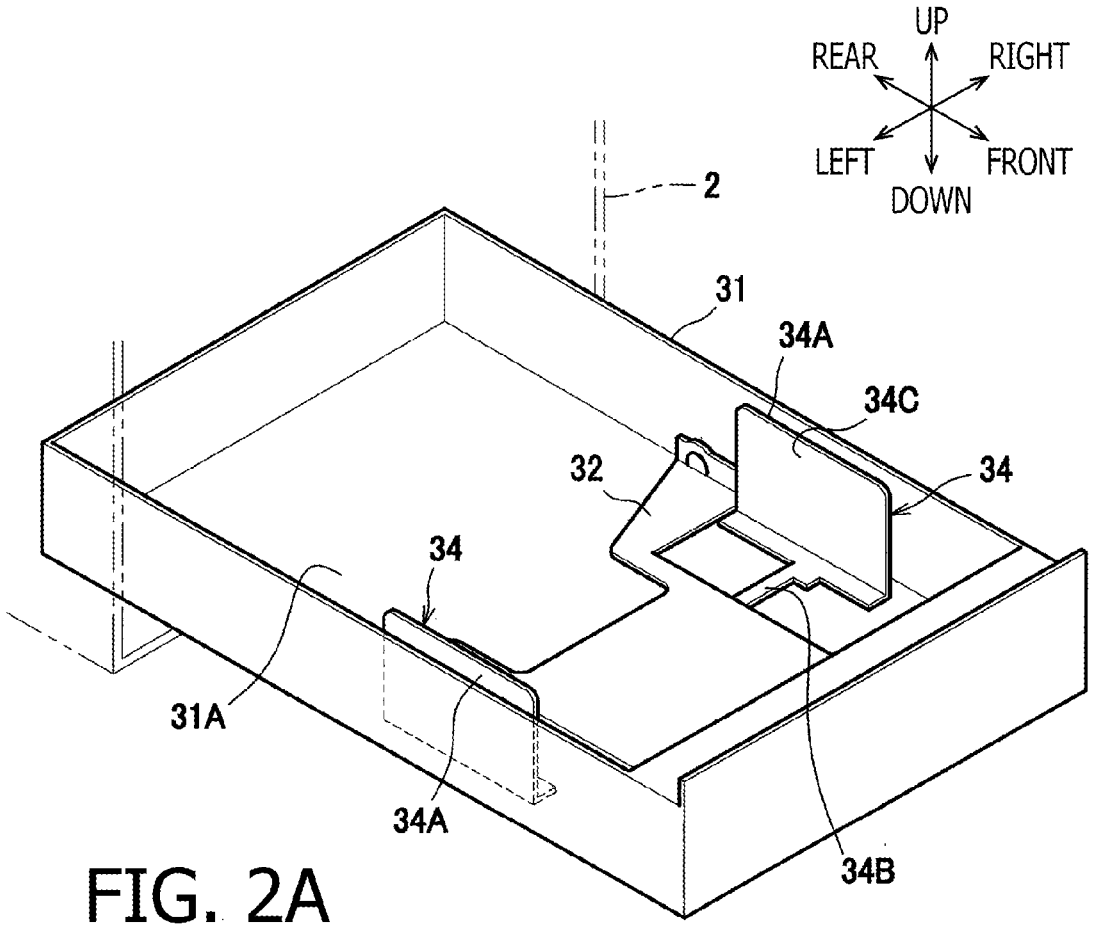

UP
REAR
RIGHT
LEFT
FRONT
DOWN
2
31
34A
34C
32
34
34
31A
34A
34B

FIG. 2A

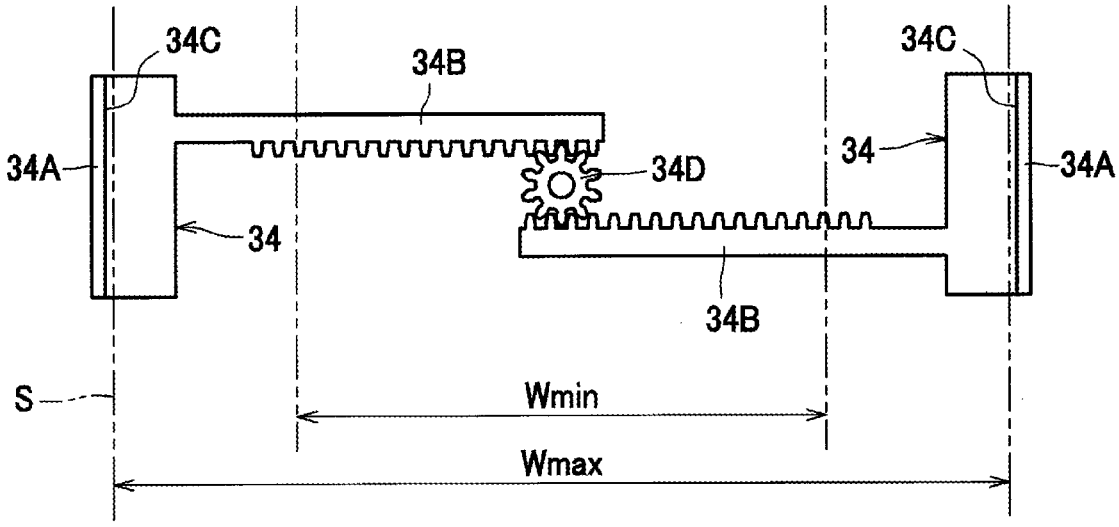

34C
34B
34C
34A
34D
34
34A
34
34B
S
Wmin
Wmax

FIG. 2B

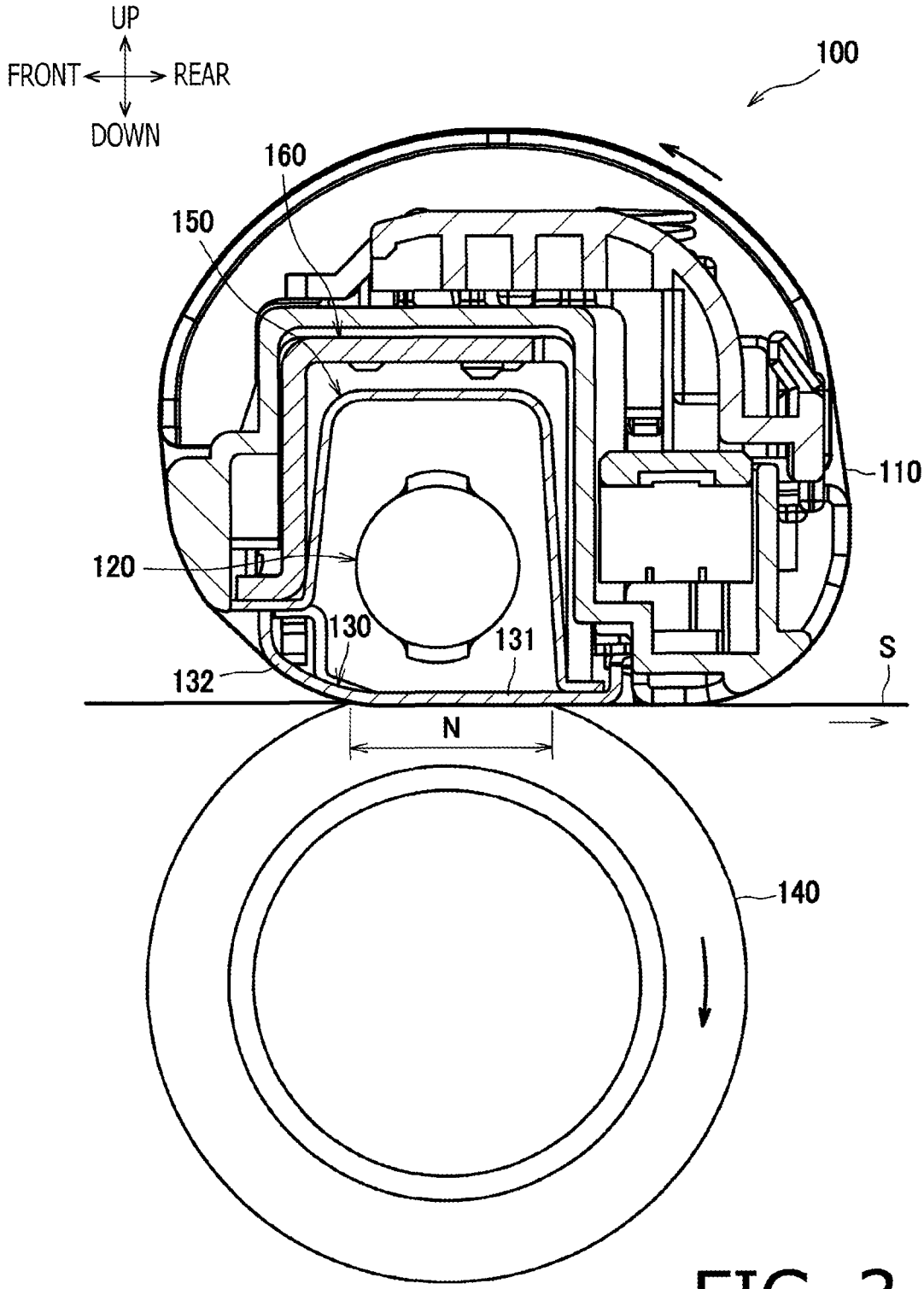


FIG. 3

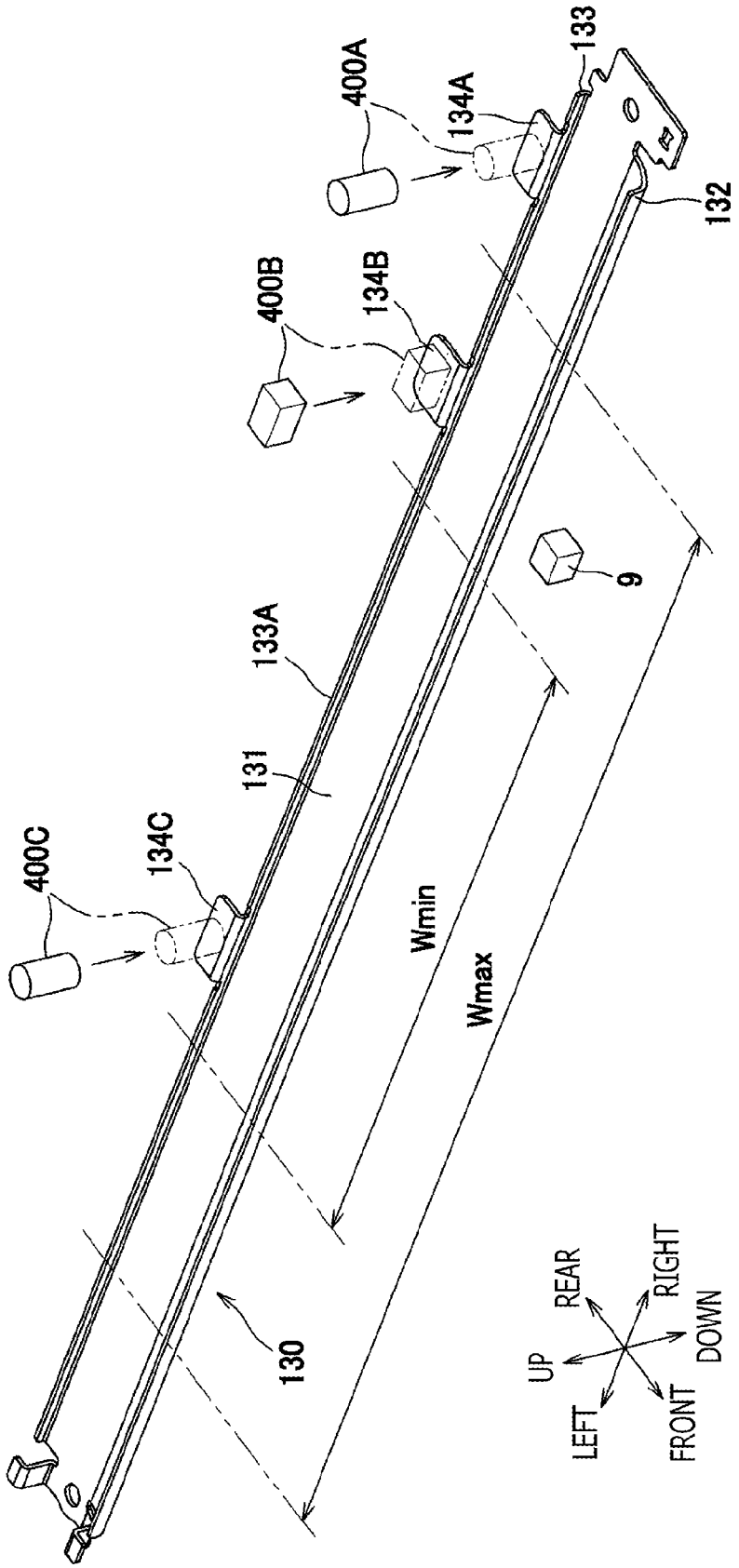

400A
134A
133
132
400B
134B
9
133A
131
400C
134C
Wmin
Wmax
130
UP
REAR
RIGHT
DOWN
LEFT
FRONT

FIG. 4

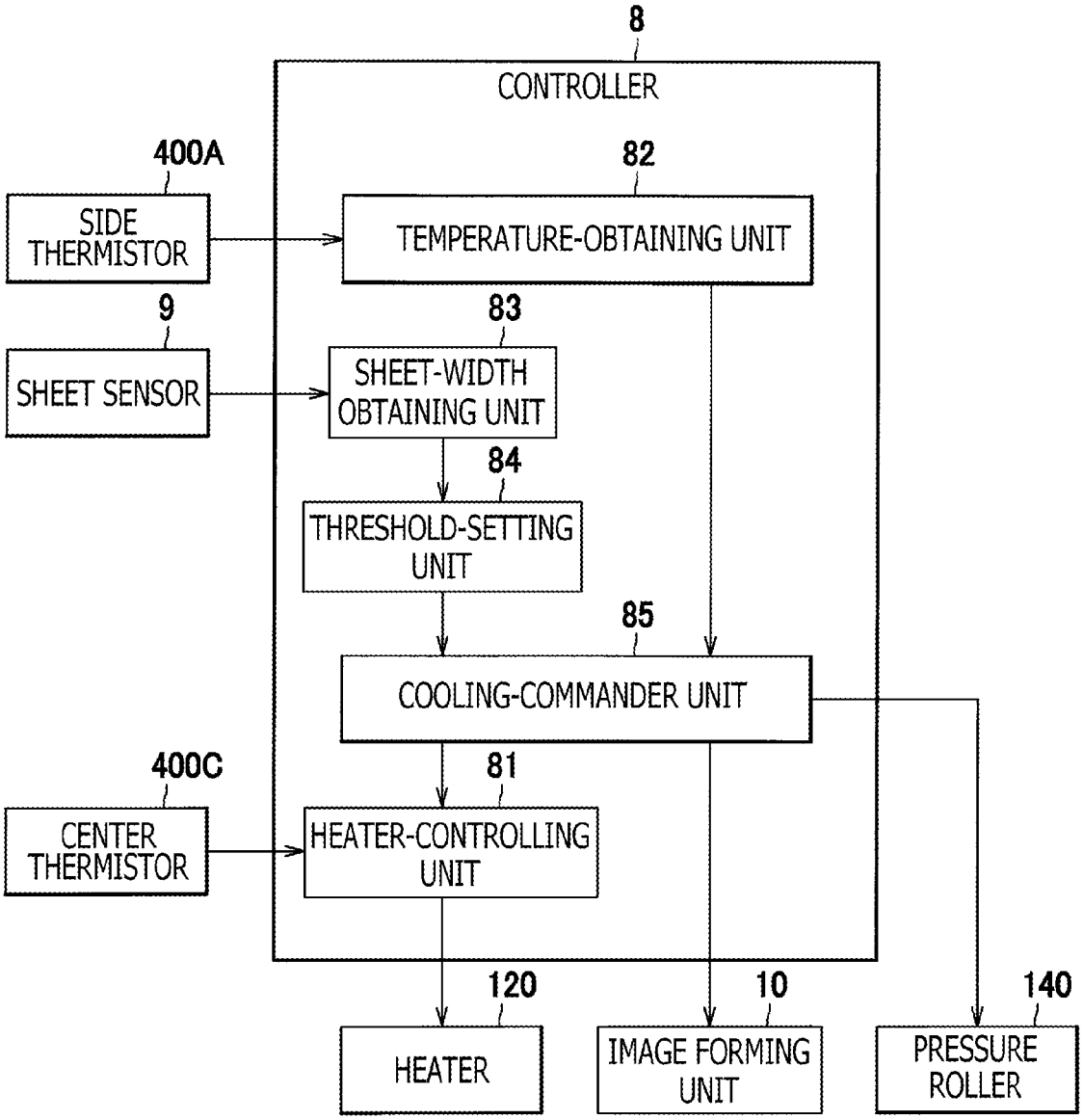

8
CONTROLLER
400A
SIDE THERMISTOR
82
TEMPERATURE-OBTAINING UNIT
9
SHEET SENSOR
83
SHEET-WIDTH OBTAINING UNIT
84
THRESHOLD-SETTING UNIT
85
COOLING-COMMANDER UNIT
400C
CENTER THERMISTOR
81
HEATER-CONTROLLING UNIT
120
HEATER
10
IMAGE FORMING UNIT
140
PRESSURE ROLLER

FIG. 5

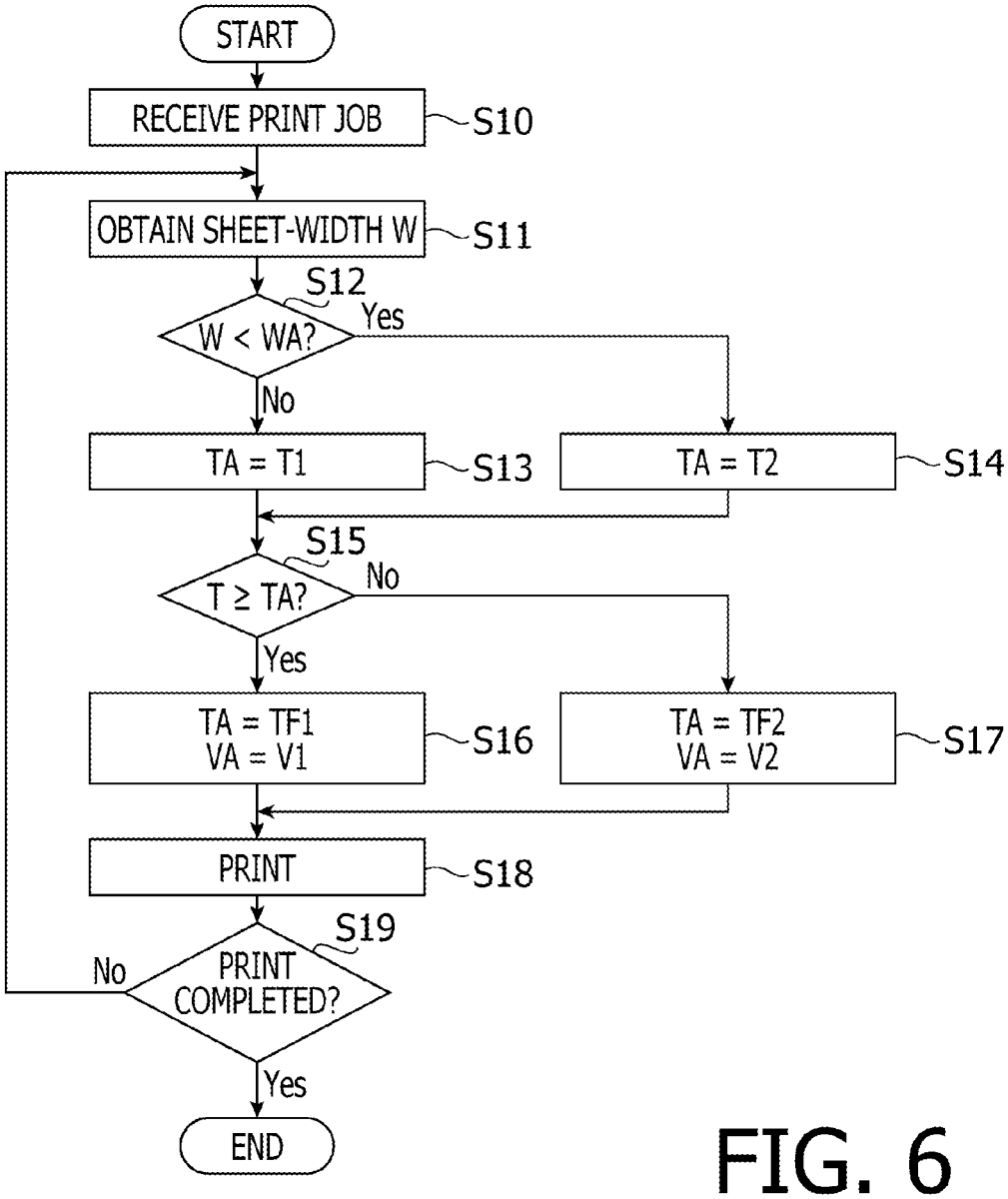

START
RECEIVE PRINT JOB
S10
OBTAIN SHEET-WIDTH W
S11
S12
W < WA?
Yes
No
TA = T1
S13
TA = T2
S14
S15
T ≥ TA?
No
Yes
TA = TF1
VA = V1
S16
TA = TF2
VA = V2
S17
PRINT
S18
S19
PRINT COMPLETED?
No
Yes
END

FIG. 6

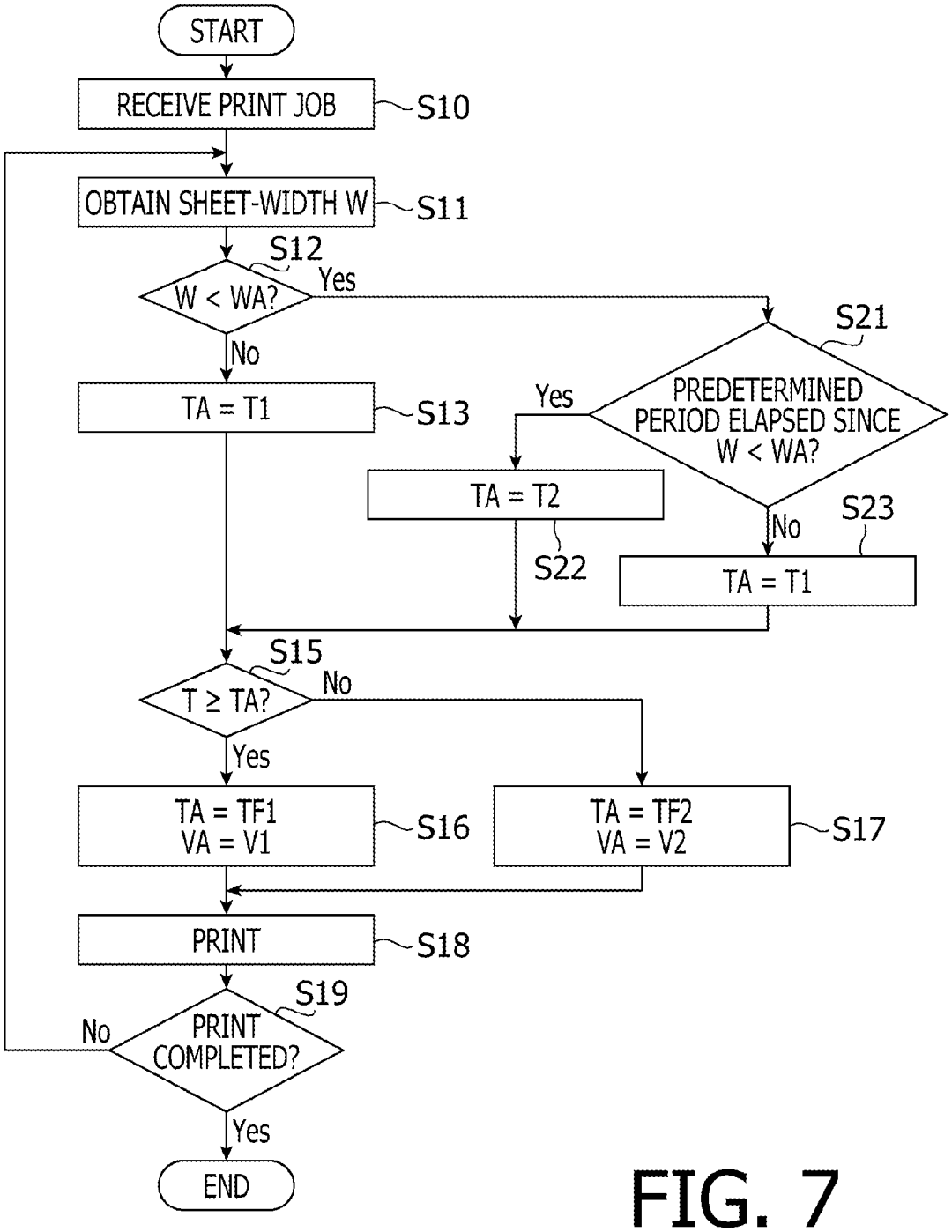

START
RECEIVE PRINT JOB
S10
OBTAIN SHEET-WIDTH W
S11
S12
W < WA?
Yes
No
TA = T1
S13
S21
PREDETERMINED PERIOD ELAPSED SINCE W < WA?
Yes
No
TA = T2
S22
S23
TA = T1
S15
T ≥ TA?
No
Yes
TA = TF1
VA = V1
S16
TA = TF2
VA = V2
S17
PRINT
S18
S19
PRINT COMPLETED?
No
Yes
END

FIG. 7

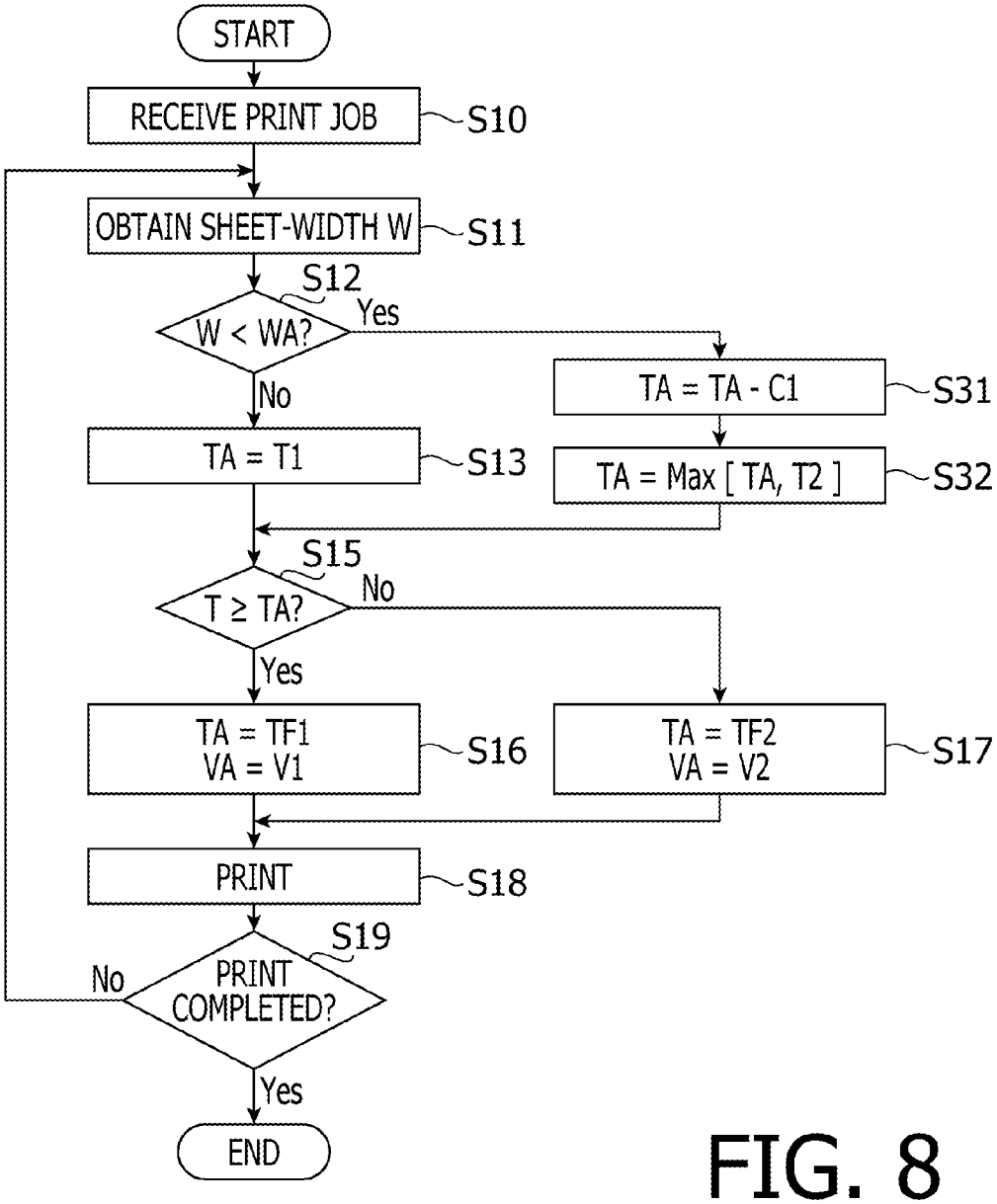

START
RECEIVE PRINT JOB
S10
OBTAIN SHEET-WIDTH W
S11
S12
W < WA?
Yes
No
TA = TA - C1
S31
TA = T1
S13
TA = Max [TA, T2]
S32
S15
T ≥ TA?
No
Yes
TA = TF1
VA = V1
S16
TA = TF2
VA = V2
S17
PRINT
S18
S19
No
PRINT COMPLETED?
Yes
END

FIG. 8

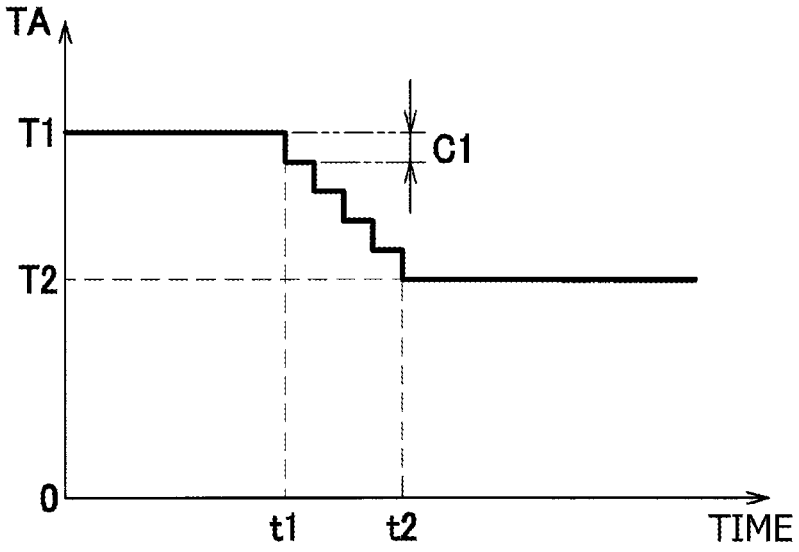


FIG. 9

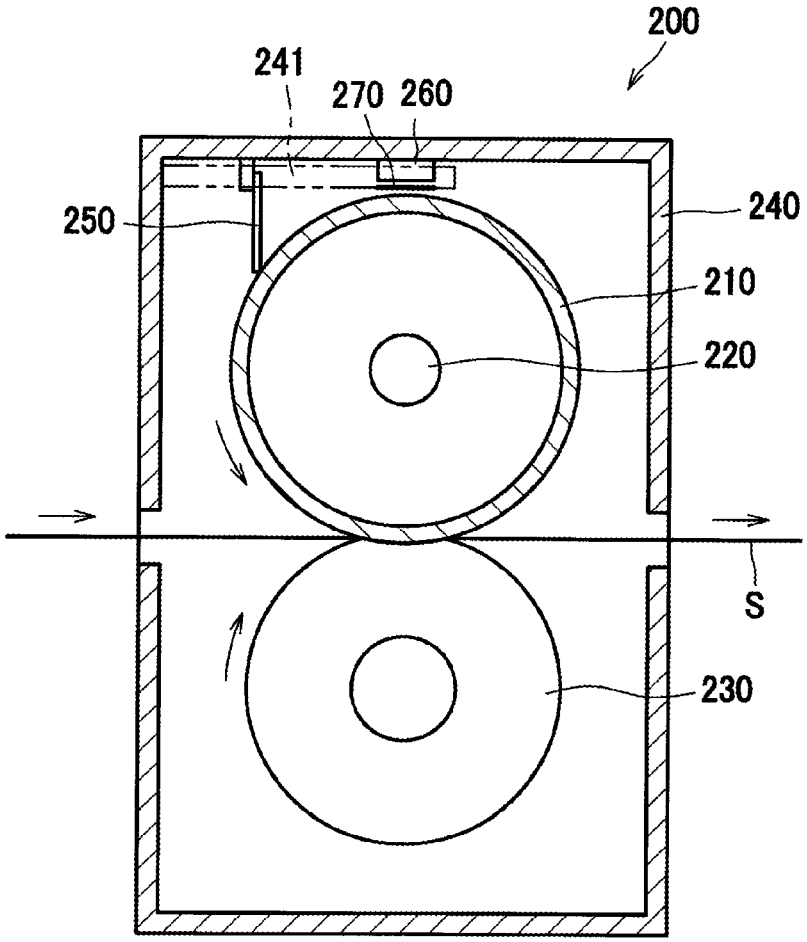


FIG. 10A

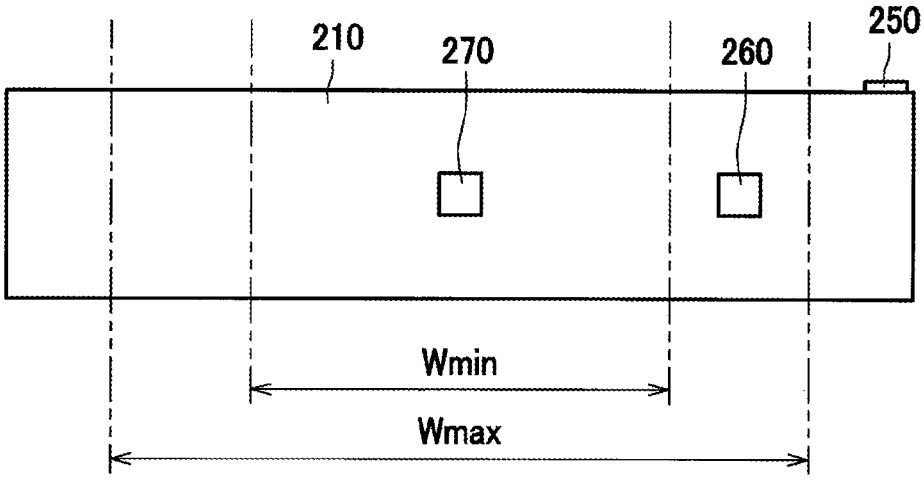


FIG. 10B

IMAGE FORMING APPARATUS WITH A HEAT-CONTROLLABLE FIXING UNIT AND COMPUTER READABLE MEDIUM FOR IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2014-093872 filed on Apr. 30, 2014, the entire subject matter of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

An aspect of the present invention relates to an image forming apparatus with a fixing unit, a method to control the image forming apparatus, and a computer readable medium to store a computer readable program to control the image forming apparatus.

2. Related Art

An image forming apparatus having a fixing unit, in which an image formed in a developer agent on a sheet is thermally fixed thereon, is known. The fixing unit may include a heating member to convey heat to the sheet, a heater to heat the heating member, and a heat sensor to detect a temperature in the heating member. In particular, the heat sensor may detect a temperature in an outer part of the heating member, which is laterally outside a pathway for the sheet being conveyed.

In the conventional fixing unit, heat in the heating member in an inner part coincident with the pathway for the sheet may be absorbed by the sheet being conveyed, while heat in the outer part of the heating member coincident with the laterally outside area of the pathway may accumulate. As the image forming apparatus continues forming images, the outer part of the heating member coincident with the laterally outside area of the pathway may be heated excessively. Therefore, the image forming apparatus may take an action to switch the heater off and abort feeding sheets when the heat sensor detects the temperature in the outer part of the heating member being higher than a predetermined degree so that the heating member may be prevented from being overheated in the outer part.

SUMMARY

According to the known image forming apparatus mentioned above, when a width of the sheet being conveyed is greater, the heat in the outer part of the heating member may tend to be absorbed by the sheet; therefore, the heat may accumulate in a smaller range in the heating member compared to the heating member when the width of the sheet being conveyed is smaller, and influence of the accumulated heat on neighboring parts in the vicinity of the outer part of the heating member may be less. Meanwhile, according to the known image forming apparatus mentioned above, the action to prevent overheat in the outer part of the heating member may be taken regardless of the width of the sheet. In other words, even when the width of the sheet being conveyed is greater, and when a smaller range of the heating member is subject to the increase of the temperature, the action to lower the temperature in the outer part of the heating member may be taken.

The present invention is advantageous in that an image forming apparatus, in which the temperature in the outer part of the heating member may be lowered depending on the width of the sheet being conveyed, is provided. Further, a method to control the image forming apparatus, and a computer usable storage device to store a program to control the image forming apparatus are provided.

According to an aspect of the present invention, an image forming apparatus, including an image forming unit configured to form an image in a developer agent on a sheet; a fixing unit including a heater and being configured to fix the image in the developer agent on the sheet; an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet; and a controller, is provided. The controller is configured to perform a width obtaining step, in which the controller obtains the width of the sheet; a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor; a comparison step, in which the controller compares the detected temperature with a threshold; a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value being different from the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width.

According to another aspect of the present invention, a method configured to be implemented on a processor to control an image forming apparatus, which includes an image forming unit to form an image in a developer agent on a sheet; a fixing unit including a heater and being configured to fix the image in the developer agent on the sheet; and an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet, is provided. The method includes a width obtaining step, in which the controller obtains the width of the sheet; a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor; a comparison step, in which the controller compares the detected temperature with a threshold; a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value being different from the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width.

According to still another aspect of the present invention, a non-transitory computer readable medium storing computer readable instructions that are executable by a computer to control an image forming apparatus, when executed by the computer, is provided. While the image forming apparatus includes an image forming unit to form an image in a developer agent on a sheet, a fixing unit including a heater and being configured to fix the image in the developer agent on the sheet, and an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet, the computer readable instructions are configured to cause the computer to control the image forming apparatus by performing a width obtaining step, in which the controller obtains the width of the sheet; a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor; a comparison step, in

which the controller compares the detected temperature with a threshold; a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value being different from the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is an illustrative cross-sectional view of a laser printer according to an embodiment of the present invention.

FIG. **2**A is a perspective view of a feeder tray in the laser printer according to the embodiment of the present invention. FIG. **2**B is a plan view of a side-guide in the laser printer according to the embodiment of the present invention.

FIG. **3** is a cross-sectional view of a fixing unit in the laser printer according to the embodiment of the present invention.

FIG. **4** is a perspective view of a nipper plate, a side thermistor, a thermostat, a central thermistor, and a sheet sensor in the laser printer according to the embodiment of the present invention.

FIG. **5** is a block chart to illustrate a configuration of a controller and related components in the laser printer according to the embodiment of the present invention.

FIG. **6** is a flowchart to illustrate a flow of steps to be taken by the controller in the laser printer according to the embodiment of the present invention.

FIG. **7** is a flowchart to illustrate a first modified example of the flow of steps to be taken by the controller in the laser printer according to the embodiment of the present invention.

FIG. **8** is a flowchart to illustrate a second modified example of the flow of steps to be taken by the controller in the laser printer according to the embodiment of the present invention.

FIG. **9** is a graph to illustrate shifts of thresholds in the second modified example of the flow of steps to be taken by the controller in the laser printer according to the embodiment of the present invention.

FIG. **10**A is a cross-sectional view of the fixing unit in the laser printer according to another modified example of the present invention. FIG. **10**B is a plan view of a heat roller, a side thermistor, a thermostat, and a central thermistor in the laser printer according to the modified example of the present invention.

DETAILED DESCRIPTION

Hereinafter, an exemplary configuration of a laser printer **1** according to an embodiment of the present invention will be described with reference to the accompanying drawings. First, an overall configuration of the laser printer **1** will be described, and second, detailed configurations of a fixing unit and a controller in the laser printer **1** will be described.

In the following description, directions concerning the laser printer **1** will be referred to in accordance with a user's ordinary position to use the laser printer **1**, as indicated by arrows. For example, a viewer's left-hand side appearing in FIG. **1** is referred to as a front side of the laser printer **1**, and a right-hand side in FIG. **1** opposite from the front side is referred to as a rear side. A side which corresponds to the viewer's nearer side is referred to as a right-hand side for the user, and an opposite side from the right, which corresponds to the viewer's farther side is referred to as a left-hand side for the user. An up-down direction in FIG. **1** corresponds to a vertical direction of the laser printer **1**. Further, the right-to-left or left-to-right direction of the laser printer **1** may be referred to as a widthwise direction, and the front-to-rear or rear-to-front direction may be referred to as a direction of depth. The widthwise direction and the direction of depth are orthogonal to each other. Furthermore, directions of the drawings in FIGS. **2**A, **2**B, **3**-**4** and **10**A, **10**B are similarly based on the orientation of the laser printer **1** as defined above and correspond to those with respect to the laser printer **1** shown in FIG. **1** even when the drawings are viewed from different angles.

As shown in FIG. **1**, the laser printer **1** includes a feeder unit **3** to feed sheets S, an image forming unit **10** to form toner images on the sheets S, a fixing unit **100** to thermally fix the images on the sheets S, and a controller **8**, which are accommodated in a main chassis **2**.

The feeder unit **3** is disposed in a lower position in the chassis **2** and includes a feeder tray **31** and a feeder device **33**.

The feeder tray **31** is a top-open box to accommodate the sheets S and is attachable to the main chassis **2**. The feeder tray **31** may be pulled forward to be drawn out of the main chassis **2** and pushed rearward to be attached to the main chassis **2**.

The feeder tray **31** includes, as shown in FIG. **2**A, a bottom **31**A, on which the sheets S are stacked, a sheet-pressing board **32**, and a pair of side-guides **34**, which are arranged on the bottom **31**A.

The sheet-pressing board **32** is swingably supported at a rear end thereof by the feeder tray **31**. When a front end of the sheet-pressing board **32** moves upward, the sheets S stored in the feeder tray **31** are uplifted.

The pair of side-guides **34** are arranged in the feeder tray **31** to face with each other along a direction of width of the sheets S, i.e., along the widthwise direction, across the sheets S (see FIG. **2**B). Each side-guide **34** includes a guide fence **34**A and a rack gear **34**B, and is movable along the widthwise direction.

Each guide fence **34**A stands vertically and has a restrictive face **34**C, which faces inward with regard to the widthwise direction. While the guide fences **34**A are arranged to be spaced apart from each other along the widthwise direction and placed to contact widthwise ends of the sheets S, a position of the sheets with regard to the widthwise direction is restricted.

As shown in FIG. **2**B, each rack gear **34**B is formed to extend inward from a lower part of the guide fence **34**A along the widthwise direction. The rack gear **34**B is formed to have gear teeth on a side that faces the other rack gear **34**B, and the gear teeth are meshed with a pinion gear **34**D, which is arranged on the feeder tray **31** at an intermediate position between the rack gears **34**B. The pinion gear **34**D links the paired side-guides **34** to be movable in conjunction with each other. Thereby, when one of the paired side-guides **34** is moved along the widthwise direction to fit with the widthwise end of the sheets S, the other of the paired side-guides **34** is moved along symmetrically in the widthwise direction. Thus, the paired side-guides **34** are arranged on each widthwise side of the sheets S to restrict a position of the sheets S interposed there-between and gather the sheets S at a widthwise center in the feeder tray **31**.

The paired side-guides **34** are, when widened to a maximum width, i.e., when placed at outermost positions along the widthwise direction, capable of restricting the position of the

sheets S with a maximum width usable in the laser printer **1**. Meanwhile, when narrowed to a minimum width, i.e., when placed at innermost positions along the widthwise direction, the paired side-guides **34** are capable of restricting the position of the sheets S with a minimum width usable in the laser printer **1**. In other words, when the paired side-guides **34** are widened at the maximum width, the restrictive faces **34**C are placed in positions corresponding to widthwise ends of a maximum-width sheet pathway Wmax, which is an area for the sheet S with the maximum width is allowed to pass through, and when the paired side-guides **34** are narrowed at the minimum width, the restrictive faces **34** are placed in positions corresponding to widthwise ends of a minimum-width sheet pathway Wmin, which is an area for the sheet S with the minimum width is allowed to pass through.

In the feeder unit **3** configured as above, the sheets S stored in the feeder tray **31** are uplifted by the sheet-pressing board **32** and fed to the image forming unit **10** by the feeder device **33**.

Referring back to FIG. **1**, the image forming unit **10** includes an exposure device **4** and a processing cartridge **5**.

The exposure device **4** is disposed in an upper position in the main chassis **2** and includes a laser emitter (not shown), a polygon mirror (unsigned), lenses (unsigned), and reflection mirrors (unsigned). In the exposure device **4**, a laser beam is emitted from the laser emitter and transmitted to a surface of a photosensitive drum **61** in the processing cartridge **5** via the polygon mirrors, the lenses, and the reflection mirrors to scan the surface of the photosensitive drum **61**.

The processing cartridge **5** is disposed in a position between the exposure device **4** and the feeder tray **31**. The processing cartridge **5** is detachably attached to the main chassis **2** through an opening (unsigned), which is exposed or covered by a front cover **21**, while the front cover **21** is pivotable on a front side of the main chassis **2**. The processing cartridge **5** includes a drum unit **6** and a developer unit **7**.

The drum unit **6** includes the photosensitive drum **61**, a charger **62**, and a transfer roller **63**. The developer unit **7** is removably attached to the drum unit **6** and includes a developer roller **71**, a supplier roller **72**, a toner-spreader blade **73**, a toner container **74** to store toner, and an agitator **75** to agitate the toner in the toner container **74**.

In the processing cartridge **5**, as the photosensitive drum **61** rotates, a surface of the photosensitive drum **61** is electrically charged evenly by the charger **62** and partly exposed to the laser beam emitted from the exposure device **4** so that electrical charges of the areas exposed to the laser beam are lowered and a latent image according to image data is formed to be carried on the surface of the photosensitive drum **61**. Meanwhile, the toner in the toner container **74** is supplied to the developer roller **71** by the supplier roller **72** and enters a position between the developer roller **71** and the toner-spreader blade **73** to be spread on the developer roller **71** to form an evenly-thinned layer.

Meanwhile, the toner on the developer roller **71** is supplied to the latent image on the photosensitive drum **61** while the developer roller **71** is rotated so that the latent image on the photosensitive drum **61** is developed to be a toner image. In the meantime, as the sheet S is conveyed through an intermediate position between the photosensitive drum **61** and the transfer roller **63**, the toner image carried on the surface of the photosensitive drum **61** is transferred onto the sheet S.

The fixing unit **100** is disposed in a rearward position with respect to the processing cartridge **5**, and the toner image transferred to the sheet S is thermally fixed on the sheet S as the sheet S passes through the fixing unit **100**. Thereafter, the sheet S is ejected by conveyer rollers **23**, **24** to a sheet outlet **22**.

As shown in FIG. **3**, the fixing unit **100** includes a fixing belt **100**, a heater **120**, a nipper board **130**, a pressure roller **140**, a reflector board **150**, and a stay **160**.

The fixing belt **110** transmits heat to the sheet S having the toner images. The fixing belt **110** is an endless belt made of a stainless steel with a heat-resistance property and flexibility. Inside the fixing belt **110**, arranged are the heater **120**, the nipper board **130**, the reflector board **150**, and the stay **160**.

The heater **120** may be, for example a halogen lamp, and radiates heat to warm the nipper board **130** and the fixing belt **100**. The heater **120** is disposed in a position spaced apart for a predetermined distance from an inner surface of the nipper board **130**.

The nipper board **130** is disposed to slidably contact an inner circumferential surface of the fixing belt **110**. The nipper board **130** is arranged to be exposed to the heat from the heater **120** and conducts the heat to the fixing belt **110**. The nipper board **130** may be a bent-formed aluminum board having a higher heat conductivity than, for example, the stay **160**, which may be made of stainless steel. The nipper board **130** includes, as shown in FIG. **4**, a straight part **131**, a front bent-part **132**, a rear bent-part **133**, and three (3) detectable parts, which are first detectable part **134**A, a second detectable part **134**B, and a third detectable part **134**C. The straight part **131** is elongated along the widthwise direction and arranged to contact the fixing belt **110**. The front bent-part **132** extends upward from a front end of the straight part **131**, and the rear bent-part **133** extends upward from a rear end of the straight part **131**.

The first, second, and third detectable parts **134**A, **134**B, **134**C are pieces, on which a side thermistor **400**A, a thermostat **400**B, and a central thermistor **400**C are placed respectively. The first, second, and third detectable parts **134**A, **134**B, **134**C are formed to extend rearward from an upper edge **133**A of the rear bent-part **133**.

The first detectable part **134**A, which is in a rightmost position among the three detectable parts **134**A, **134**B, **134**C, is formed on a rightward end of the nipper board **130** to be arranged laterally outside the maximum-width sheet pathway Wmax with regard to the widthwise direction. The second detectable part **134**B is formed in a leftward position with regard to the first detectable part **134**A, inside the maximum-width sheet pathway Wmax, and laterally outside the minimum-width sheet pathway Wmin, with regard to the widthwise direction. The third detectable part **134**C is formed in a widthwise central position in the nipper board **130** and inside the minimum-width sheet pathway Wmin, with regard to the widthwise direction.

The side thermistor **400**A to detect temperature is arranged to contact the first detectable part **134**A. In other words, the side thermistor **400**A is disposed laterally outside the maximum-width sheet pathway Wmax with regard to the widthwise direction. The side thermistor **400**A is disposed on an outer side of the restrictive face **34**C (see FIG. **2**B) of the side-guide **34** in the feeder tray **31** with regard to the widthwise direction.

The side thermistor **400**A is configured to output a signal corresponding to a temperature in the first detectable part **134**A to the controller **8**. Therefore, a temperature in the fixing belt **110** at a rightward end, more specifically, a part of the fixing belt **110** outside the maximum-width sheet pathway Wmax with regard to the widthwise direction, may be indirectly detected by the side thermistor **400**A through the first detectable part **134**A.

The thermostat **400**B is disposed to contact the second detectable part **134**B. In other words, the thermostat **400**B is disposed laterally inside the maximum-width sheet pathway Wmax and laterally outside the minimum-width sheet pathway Wmin with regard to the widthwise direction.

The thermostat **400**B detects a temperature in the second detectable part **134**B, when a temperature in a part of the fixing belt **110** corresponding to the second detectable part **134**B is increased to be greater than or equal to a third threshold, which will be described later in detail, and shuts down electricity to the heater **120** without being controlled by the controller **8**.

The central thermistor **400**C is disposed on the third detectable part **134**C. In other words, the center thermistor **400**C is disposed inside the minimum-width sheet pathway Wmin with regard to the widthwise direction.

The central thermistor **400**C is configured to output a signal corresponding to a temperature in the third detectable part **134**C to the controller **8**. Therefore, a temperature in a part of the fixing belt **110** inside the minimum-width sheet pathway Wmax with regard to the widthwise direction may be indirectly detected by the central thermistor **400**C through the third detectable part **134**C.

In a position upstream of the nipper board **130** with regard to a direction to convey the sheet S, disposed is a sheet sensor **9**. The sheet sensor **9** is disposed laterally outside the minimum-width sheet pathway Wmin and laterally inside the maximum-width sheet pathway Wmax with regard to the widthwise direction. The sheet sensor **9** may be, for example, in a same position as the thermostat **400**B along the widthwise direction. The sheet sensor **9** is configured to output different signals depending on presence or absence of the sheet S at a position corresponding to the sheet sensor **9**.

Referring back to FIG. **3**, the pressure roller **140** is arranged in a lower position with regard to the nipper board **130** and forms a nipping section N to nip the fixing belt **110** in conjunction with the straight part **131** of the nipper board **130**. In order to nip the fixing belt **110** in the nipping section N, one of the nipper board **130** and the pressure roller **140** is urged against the other of the nipper board **130** and the pressure roller **140**. The pressure roller **140** is driven to be rotated by a driving force from a driving source, which is disposed in the main chassis **2** but not shown. With the fixing belt **110** and the sheet S nipped between the pressure roller **140** and the nipper board **130**, when the pressure roller **140** is driven to rotate, the fixing belt **110** is rolled along with the rotation of the pressure roller **140**, and the sheet S is conveyed rearward.

The reflector board **150** is a board, which has a characteristic of a higher reflection rate for infrared and far-infrared rays, to reflect the radiation heat from the heater **120** toward the nipper board **130** and may be, for example, an aluminum board. The reflector board **150** is formed in curve to have a cross-sectional approximate shape of a U, which surrounds the heater **120**, inside the belt **110**.

The stay **160** supports the nipper board **130** through the reflector board **150** to bear the pressure from the pressure roller **140**. The stay **160** is arranged to surround the heater **120** and the reflector board **150** inside the fixing belt **110**. The stay **160** may be, for example, a stainless sheet, which has greater rigidity than the nipper board **130**. Thus, the nipper board **130** may be restrained from being deformed by the pressure from the pressure roller **140**.

The controller **8** (see FIG. **8**) is a computing device which includes a central processing unit (CPU), a read-only memory (ROM), and a random access memory (RAM) (not shown). The controller **8** is configured to execute a cooling operation, according to the output from the side thermistor **400**A and a preinstalled program, to let a lateral end area of the fixing belt **110** cool down when a temperature in the lateral end area of the fixing belt is at a threshold TA.

The controller **8** includes, as shown in FIG. **5**, a heater-controlling unit **81**, a temperature-obtaining unit **82**, a sheet-width obtaining unit **83**, a threshold-setting unit **84**, and a cooling-commander unit **85**.

The heater-controlling unit **81** is configured to control the heater **120**, according to the output from the central thermistor **400**C, to maintain the temperature in a widthwise central area of the fixing belt **110** at a predetermined fixing temperature TF.

The temperature-obtaining unit **82** is configured to obtain a temperature T in a rightward end area of the fixing belt **110** according to the output from the side thermistor **400**A.

The sheet-width obtaining unit **83** is configured to execute an obtaining operation, according to the output from the sheet sensor **9**, to obtain a width W of the sheet S being conveyed. For example, in the obtaining operation, the sheet-width obtaining unit **83** may determine that the width W of the sheet S being conveyed is greater than or equal to a predetermined width WA when the sheet sensor **9** detects the sheet S and that the width W of the sheet S being conveyed is smaller than the predetermined width WA when the sheet sensor **9** does not detect the sheet S. The obtaining operation may be executed at a predetermined timing, in which the sheet S being conveyed passes through the position corresponding to the sheet sensor **9**.

Optionally, the sheet-width obtaining unit **83** may determine the width W of a first sheet S being conveyed based on information concerning the sheet S, which may be input by the user, and the width W of a second and succeeding sheets S being conveyed based on the output from the sheet sensor **9**.

The threshold-setting unit **84** is configured to execute a threshold-setting operation, in which a first threshold T**1** is set to be the threshold TA when the width W of the sheet S obtained in the obtaining operation is greater than or equal to the predetermined width WA, and a second threshold T**2** is set to be the threshold TA when the width W of the sheet S obtained in the obtaining operation is smaller than the predetermined width WA. In this regard, the second threshold T**2** is smaller than the first threshold T**1**. In the meantime, the above-mentioned third threshold is greater than the second threshold T**2** and smaller than the first threshold T**1**.

The cooling-commander unit **85** is configured to execute a cooling-commander operation, in which a command to execute the cooling operation is issued when the temperature T in the rightward end area of the fixing belt **110** obtained by the temperature-obtaining unit **82** is greater than or equal to the threshold TA. Upon executing the cooling operation, the cooling-commander unit **85** may issue a command to let the temperature in the central area of the fixing belt **110** be lower than a regular-driving temperature, which is a temperature in the central area of the fixing belt **110** when the cooling operation is not performed, and to reduce a conveying velocity to convey the sheet S to be lower than a regular-driving velocity, which is a velocity to convey the sheet S when the cooling operation is not performed.

More specifically, when the temperature T in the rightward end area of the fixing belt **110** is determined to be lower than the threshold TA, the cooling-commander unit **85** sets a first fixing temperature TF**1** to be a fixing temperature TF and a first conveying velocity V**1** to be a conveying velocity VA to convey the sheet S. On the other hand, when the temperature T in the rightward end area of the fixing belt **110** is determined to be higher than or equal to the threshold TA, the cooling-commander unit **85** sets a second fixing temperature TF**2**,

which is lower than the first fixing temperature TF1, to be the fixing temperature TF and a second velocity V2, which is slower than the first velocity V1, to be the conveying velocity VA to convey the sheet S. Further, the cooling-commander unit **85** manipulates the heater-controlling unit **81** to control the heater **120** so that the temperature in the central area of the fixing belt **110** is maintained at the fixing temperature TF. Furthermore, the cooling-commander unit **85** controls the image forming unit **10** and the pressure roller **140** to convey the sheet S at the conveying velocity VA.

Next, referring to FIG. **6**, detailed behaviors of the controller **8** will be described. When the controller **8** receives a print job (S**10**), the controller **8** obtains the width W of the sheet S being conveyed (S**11**).

In S**12**, the controller **8** determines if the obtained width W of the sheet S is smaller than the predetermined width WA (S**12**). When the width W of the sheet S being conveyed is determined to be greater than or equal to the predetermined width WA (S**12**: NO), the controller **8** sets the first threshold T**1** to be the threshold TA (S**13**). On the other hand, when the width W of the sheet S being conveyed is determined to be smaller than the predetermined width WA (S**12**: YES), the controller **8** sets the second threshold T**2** to be the threshold TA (S**14**).

After setting the threshold TA in S**13** or S**14**, the controller **8** determines if the temperature T in the rightward end of the fixing belt **110** detected by the side thermistor **400**A is higher than or equal to the threshold TA (S**15**).

In S**15**, when the temperature T of the rightward end of the fixing belt **110** is determined to be lower than the threshold TA (S**15**: NO), the controller **8** sets the first fixing temperature TF**1** to be the fixing temperature TF and the first velocity V**1** to be the conveying velocity VA to convey the sheet S (S**16**). On the other hand, when the temperature T of the rightward end of the fixing belt **110** is determined to be higher than or equal to the threshold TA (S**15**: YES), the controller **8**, more specifically, the cooling-commander unit **85**, sets the second fixing temperature TF**2** to be the fixing temperature TF and the second velocity V**2** to be the conveying velocity VA to convey the sheet S (S**17**).

After setting the conveying velocity VA to convey the sheet S in S**16** or S**17**, the controller **8** manipulates the feeder unit **3** to convey the sheet S at the conveying velocity VA and the image forming unit **10** to form the image based on the print job (S**18**). After forming a first page of the print job, the controller **8** determines if the print job should end thereat (S**19**). When the print job is determined to end thereat (S**19**: YES), the controller **8** finishes the printing operation. On the other hand, when the print job is determined to be continued (S**19**: NO), the controller **8** returns to S**11** and continues the print job.

According to the laser printer **1** configured as above, when the sheet S passes through the fixing unit **100**, the sheet S absorbs the heat in the fixing belt **110**. Therefore, a temperature in the part of the fixing belt **110** that contacts the sheet S is lowered. When the temperature in the fixing belt **100** is lowered, the heater-controlling unit **81** in the controller **8** manipulates the heater **120** to heat the fixing belt **110** so that the temperature in the central area of the fixing belt **110** is maintained at the first fixing temperature TF**1**. In this regard, however, in lateral end areas of the fixing belt **110**, where the sheet S being conveyed does not contact, the heat is not absorbed by the sheet S but accumulates. Therefore, the temperature in the lateral end areas may increase to be higher than the central part, where the sheet S being conveyed contacts.

As the temperature in the lateral end areas increases, when the side thermistor **400** detects the temperature T in the rightward end area of the fixing belt **110** being higher than or equal to the threshold TA, the controller **8** activates the cooling operation.

When the cooling operation is performed, the heater **120** is controlled to adjust the temperature T at the central area of the fixing belt **110** to be the second fixing temperature TF **2**, which is lower than the first fixing temperature TF**1** of the regular-driving temperature. In other words, the output from the heater **120** is reduced. Thus, with the reduced output from the heater **120**, the heat to be conducted from the heater **120** to the lateral end areas of the fixing belt **110** may be reduced, and the fixing belt **110** may be restrained from being heated up at the lateral end areas.

In the meantime, while the cooling operation is performed, the sheet S is conveyed at the second velocity V**2**, which is slower than the first velocity V**1** of the regular-driving conveying velocity. Therefore, although the temperature in the fixing belt **110** is at the second fixing temperature TF**2**, which is lower than the first fixing temperature TF**1** being the regular-driving temperature, the toner image may be substantially thermally fixed on the sheet S.

When the width W of the sheet S being conveyed is greater, the heat in a larger area in the fixing belt **110** may be absorbed by the sheet S. Therefore, compared to the sheet S with a smaller width, the heat may accumulate in a smaller area in the fixing belt **110**, and influence by the heat on the neighboring parts may be limited. In consideration of that, according to the embodiment described above, the first threshold T**1** is set to be the threshold TA when the width W of the sheet S is greater than or equal to the predetermined width WA, while the second threshold T**2** being lower than the first threshold T**1** is set to be the threshold TA when the width W of the sheet S is smaller than the predetermined width WA. In other words, when the width W of the sheet S is greater than or equal to the predetermined width WA, the cooling operation to let the lateral end areas of the fixing belt **110** cool down may be restrained from being performed.

Further, while the side thermistor **400**A is disposed laterally outside the maximum-width sheet pathway Wmax with regard to the widthwise direction, the side thermistor **400**A may detect the temperature in the area of the fixing belt **110**, in which the temperature is not absorbed by the sheet S, so that the cooling operation may be effectively performed depending on the temperature in the lateral end areas. In other words, the lateral end areas of the fixing belt **110** may be efficiently prevented from being overheated.

Moreover, while the third threshold is set to be higher than the second threshold T**2**, the cooling operation may be activated before the thermostat **400**B shuts down the electricity to the heater **120**.

The sheet S passes through the position corresponding to the thermostat **400**B when the width W of the sheet S is greater than or equal to the predetermined width WA. Therefore, even when the temperature T in the fixing belt **110** detected by the side thermistor **400**A exceeds the third threshold, the temperature in the part of the fixing belt **110** corresponding to the position of the thermostat **400**B may not necessarily exceed the third threshold. In this regard, according to the present embodiment, the third threshold is smaller than the first threshold T**1**. Therefore, it may be prevented that the cooling operation is activated when the thermostat **400**B does not shut down the electricity to the heater **120**.

Although an example of carrying out the invention has been described, those skilled in the art will appreciate that there are numerous variations and permutations of the image forming apparatus, the method and the program to control the image forming program that fall within the spirit and scope of

the invention as set forth in the appended claims. It is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or act described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims. In the meantime, the terms used to represent the components in the above embodiment may not necessarily agree identically with the terms recited in the appended claims, but the terms used in the above embodiment may merely be regarded as examples of the claimed subject matters.

Next, modified examples of the above embodiment will be described below. In the following examples, items or structures which are the same as or similar to the items or the structures described in the previous embodiment will be referred to by the same reference signs, and description of those will be omitted.

For example, in the threshold-setting operation, the second threshold T**2** may not necessarily be set to be the threshold TA each time when the width W of the sheet S obtained in the obtaining operation is smaller than the predetermined width WA. But the controller **8** may set the second threshold T**2** to be the threshold TA after holding for a predetermined length of period from a point, at which the width W of the sheet S obtained in the obtaining operation changes from the predetermined width WA or greater to the smaller width which is smaller than the predetermined width WA.

More specifically, as shown in FIG. **7**, in S**12**, when the controller **8** determines that the width W of the sheet S to be smaller than the predetermined width WA (S**12**: YES), in S**21**, the controller **8** may determine if the predetermined length of period elapsed after the width W of the sheet S indicated the smaller width than the predetermined width WA.

In S**21**, if the controller **8** does not determine that the predetermined length of period elapsed after the width W of the sheet S indicated the smaller width than the predetermined width WA (S**21**: NO), in S**23**, the controller **8** may set the first threshold T**1** to be the threshold TA. On the other hand, in S**21**, if the controller **8** determines that the predetermined length of period elapsed after the width W of the sheet S indicated the smaller width than the predetermined width WA (S**21**: YES), in S**22**, the controller **8** may set the second threshold T**2** to be the threshold TA. After setting the threshold TA in S**23** or S**22**, the flow may proceed to S**15**.

Thus, by maintaining the threshold TA at the first threshold TA for the predetermined length of period after the width W of the sheet S changes from the greater width to the smaller width, the cooling operation may be prevented from being activated too early after the threshold TA is switched to the smaller value.

For another example, in the threshold-setting process, the threshold TA may be decreased gradually from the first threshold T**1** to the second threshold T**2** when the width W of the sheet S obtained in the obtaining operation changes from the value greater than or equal to the predetermined width WA to the value smaller than the predetermined width WA.

In particular, as shown in FIG. **8**, after determining that the width W of the sheet S is smaller than the predetermined width WA in S**12** (S**12**: YES), in S**31**, the controller **8** may subtract a constant C**1** from the current threshold TA. In S**32**, the controller **8** may compare the subtracted difference with the second threshold T**2** and set a larger value to be a new threshold TA. The flow may thereafter proceed to S**15**.

With this flow, as shown in FIG. **9**, after the width W of the sheet S obtained in the obtaining operation changes from the predetermined width WA or greater to the width smaller than the predetermined width WA (time: t**1**) and until the predetermined length of period elapses (time: t**2**), a plurality of thresholds, which decrease gradually by the constant C**1** from the first threshold T**1** to the second threshold T**2**, may be set to be the threshold TA. After the predetermined length of period (time: t**2** and onward), the second threshold T**2** should be greater than the difference calculated by subtracting the constant C**1** from the threshold TA; therefore, the threshold TA may stay at the second threshold T**2**.

For another example, the fixing unit **100** may not necessarily be equipped with the fixing belt **110** that is heated by the heater **120** to fix the image on the sheet S, but a fixing unit **200** may be equipped with, for example, a heat roller **210** as shown in FIG. **10**A.

In the fixing unit **200**, the heat roller **210** may be formed in a cylindrical shape, in which a heater **220** to heat the heat roller **210** is disposed, and a pressure roller **230** may be urged against the heat roller **210**. As the sheet S passes through an intermediate position between the heat roller **210** and the pressure roller **230**, the sheet S may be heated.

In the previous embodiment, the lateral thermistor **400**A detects the temperature in the first detectable part **134**A of the nipper board **130** to detect the lateral end part of the fixing belt **110** indirectly. Meanwhile, according to the above-mentioned configuration as shown in FIG. **10**A, a side thermistor **250** may directly contact the lateral end part of the heat roller **210** to detect the temperature therein.

In particular, the lateral thermistor **250** may be supported by a frame **240**, which may accommodate the heat roller **210** and the pressure roller **230**, and may contact a surface of the heat roller **210**. In this regard, as shown in FIG. **10**B, the side thermistor **250** may be disposed laterally outside the maximum width sheet pathway Wmax with regard to the widthwise direction. Meanwhile, a thermostat **260** and a central thermistor **270** may be arranged to face with and spaced apart from the heat roller **210**, as shown in FIG. **10**A.

As shown in FIGS. **10**A-**10**B, the thermostat **260** may be fixed to the frame **240** in an upper position with respect to the heat roller **210**, inside the maximum width sheet pathway Wmax and laterally outside the minimum width sheet pathway Wmi with regard to the widthwise direction. The thermostat **260** may be configured to shut down the electricity to the heater **220** when the temperature in a part of the heat roller **210** facing with the thermostat **260**, which may be estimated based on a temperature detected by the thermostat **260**, is determined to be higher than or equal to the third threshold.

Meanwhile, the central thermistor **270** may be supported by a supporting member **241**, which may be fixed to the frame **240**, in a position laterally inside the minimum width sheet pathway Wmin with regard to the widthwise direction, and may be configured to detect a temperature in a part of the heat roller **210** facing with the central thermistor **270**.

In the previous embodiment, the temperature in the lateral end part of the fixing belt **110** may be lowered by lowering the temperature in the central part of the fixing belt **110** and lowering the conveying velocity VA to convey the sheet S in the cooling operation, which may be activated by the output from the cooling-commander unit **85**. However, a cooling method to lower the temperature in the fixing belt **110** may not necessarily be limited to that described above. For example, the temperature in the lateral end part of the fixing belt **110** may be lowered by stopping the printing operation for a predetermined length of period or by placing a longer interval between the sheets S being fed according to output from the cooling-commander unit **85**. Additionally or alternatively, a cooling device such as a fan may be employed.

For another example, in the obtaining operation, the width W of the sheet S may not necessarily be determined based on

the output from the sheet sensor **9** but may be determined by output from a sensor (not shown), which detects a position of the paired side-guides **34**. For another example, the width W of the sheet S being conveyed may be determined based on changes of the temperatures in the central thermistor **400**C and the side thermistor **400**A.

For another example, the width W of the sheet S may not necessarily be determined between the two values: the value greater than or equal to the predetermined width WA; or the value smaller than the predetermined width WA. But the width W of the sheet S may be determined among three or more width ranges. In this regard, the threshold TA may be set among three or more values, each of which corresponds to one of the three or more width ranges. Additionally or alternatively, the methods to lower the temperature in the fixing belt **110** may be varied depending on the thresholds TA.

For another example, the paired side-guides **34** may not necessarily be configured to move to be closer to each other toward the widthwise center to restrict the positions of the widthwise ends of the sheets S, but one of the paired side-guides may be movable to be closer to the other of the paired side-guides along the widthwise direction so that one of the widthwise ends of the sheet S on the movable one of the paired side-guides may be restricted. In this regard, the side thermistor may be arranged to detect a temperature in the lateral end part of the fixing belt **110** on the side of the movable one of the paired side-guides with regard to the widthwise direction.

For another example, the sheet S may not necessarily be paper but may be, for example, an OHP sheet.

What is claimed is:

1. An image forming apparatus, comprising:

an image forming unit configured to form an image in a developer agent on a sheet;

a fixing unit comprising a heater, the fixing unit being configured to fix the image in the developer agent on the sheet;

an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet; and

a controller configured to perform:

a width obtaining step, in which the controller obtains the width of the sheet;

a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor;

a comparison step, in which the controller compares the detected temperature with a threshold;

a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and

a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value smaller than the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width, the second value corresponding to a lower conveying velocity to convey the sheet than a conveying velocity corresponding to the first value.

2. The image forming apparatus according to claim **1**,

wherein the end temperature sensor is disposed outside a pathway, in which the sheet with a maximum usable width is allowed to pass through.

3. The image forming apparatus according to claim **1**, further comprising:

a side-guide comprising a restrictive face, the restrictive face being configured to restrict a position of the sheet with regard to the widthwise direction,

wherein the end temperature sensor is disposed on an outer side of the restrictive face with regard to the widthwise direction.

4. The image forming apparatus according to claim **3**,

wherein the side-guide is movable along the widthwise direction.

5. The image forming apparatus according to claim **4**,

wherein the side-guide comprises a first side-guide, a second side-guide arranged to be spaced apart from the first side-guide along the widthwise direction, and a link to couple the first-side guide and the second side-guide to be movable in conjunction with each other.

6. The image forming apparatus according to claim **1**,

wherein, in the threshold-setting step, the controller is configured to hold for a predetermined length of time from a point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to a width smaller than the predetermined width, before setting the second value to be the threshold.

7. The image forming apparatus according to claim **6**,

wherein, in the threshold-setting step, the controller sets values decreasing gradually from the first value to the second value to be the threshold within the predetermined length of time.

8. The image forming apparatus according to claim **6**,

wherein, in the threshold-setting step, the controller is configured to maintain the first value to be the threshold for the predetermined length of time from the point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to the width smaller than the predetermined width, and to set the second value to be the threshold after the predetermined length of time.

9. The image forming apparatus according to claim **1**, further comprising:

a central temperature sensor disposed inside a pathway for the sheet with a minimum width,

wherein the controller is configured to control a temperature in the heater according to a temperature detected by the central temperature sensor.

10. The image forming apparatus according to claim **9**, further comprising:

a thermal cutoff configured to shut down electricity to the heater.

11. The image forming apparatus according to claim **1**,

wherein the second value corresponds to a temperature lower than a temperature corresponding to the first value.

12. An image forming apparatus comprising:

an image forming unit configured to form an image in a developer agent on a sheet;

a fixing unit comprising a heater, the fixing unit being configured to fix the image in the developer agent on the sheet;

an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet; and

a controller configured to perform:

a width obtaining step, in which the controller obtains the width of the sheet;

a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor;

a comparison step, in which the controller compares the detected temperature with a threshold;

a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and

a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value smaller than the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width,

wherein, the controller is configured to hold for a predetermined length of time from a point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to a width smaller than the predetermined width, before setting the second value to be the threshold.

13. The image forming apparatus according to claim **12**,

wherein, in the threshold-setting step, the controller sets values decreasing gradually from the first value to the second value to be the threshold within the predetermined length of time.

14. The image forming apparatus according to claim **12**,

wherein, in the threshold-setting step, the controller is configured to maintain the first value to be the threshold for the predetermined length of time from the point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to the width smaller than the predetermined width, and to set the second value to be the threshold after the predetermined length of time.

15. A non-transitory computer readable medium storing computer readable instructions that are executable by a computer to control an image forming apparatus, when executed by the computer, the image forming apparatus comprising an image forming unit configured to form an image in a developer agent on a sheet; a fixing unit comprising a heater, the fixing unit being configured to fix the image in the developer agent on the sheet; and an end temperature sensor disposed on an end area of the fixing unit with regard to a direction of width of the sheet, the computer readable instructions being configured to cause the computer to control the image forming apparatus by performing:

a width obtaining step, in which the controller obtains the width of the sheet;

a temperature obtaining step, in which the controller obtains a temperature of the fixing unit detected by the end temperature sensor;

a comparison step, in which the controller compares the detected temperature with a threshold;

a cooling step, in which the controller manipulates the heater to let the end area of the fixing unit cool down when the temperature detected by the end temperature sensor is one of higher and equal to the threshold; and

a threshold-setting step, in which the controller sets a first value to be the threshold when the width of the sheet obtained in the width obtaining step is one of greater and equal to a predetermined width, and in which the controller sets a second value smaller than the first value to be the threshold when the width of the sheet obtained in the width obtaining step is smaller than the predetermined width,

wherein, the controller is configured to hold for a predetermined length of time from a point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to a width smaller than the predetermined width, before setting the second value to be the threshold.

16. The non-transitory computer readable medium according to claim **15**,

wherein, in the threshold-setting step, the controller sets values decreasing gradually from the first value to the second value to be the threshold within the predetermined length of time.

17. The non-transitory computer readable medium according to claim **15**,

wherein, in the threshold-setting step, the controller is configured to maintain the first value to be the threshold for the predetermined length of time from the point, at which the width of the sheet obtained in the width-obtaining step changes from one of greater than and equal to the predetermined width to the width smaller than the predetermined width, and to set the second value to be the threshold after the predetermined length of time.

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